noise in the community. In addition, previous studies on effects of noise on wildlife indicate that even very high intermittent noise levels at INEEL (over 100 dBA) would not affect wildlife productivity (Leonard 1993).

4.11 Health and Safety

This section presents the potential health effects to the public and workers as a result of current operations at INEEL. The discussion includes estimates of impacts from the release of radioactive and nonradioactive material and also includes occupational injury rates. Emphasis is placed on updating information presented in SNF & INEL EIS (DOE 1995a) from which this document is tiered. Since INTEC employees would be affected most by the waste processing and facility disposition alternatives, this section emphasizes occupational health and safety at INTEC. Background information related to the material presented in this section and details on the health effects methodology are included in Appendix C.3.

4.11.1 PUBLIC HEALTH AND SAFETY

As discussed in Section 4.7, the primary way in which activities under consideration in this EIS could affect public health is through airborne emissions. There is also a possibility of contamination of groundwater under the INEEL, and as noted in Section 4.8, this groundwater is part of the Snake River Plain aquifer, which has been designated a sole source aquifer. Nevertheless, any contamination of soil or groundwater at the INEEL would not be expected to significantly affect the offsite public because of the large size of the site and the large distances between the INTEC area and the offsite public.

The analyses of possible public health effects from projected air or water emissions presented in this EIS tend to be conservative, indicating higher results than would actually be expected to occur.

A number of independent entities monitor and track both radioactive and nonradioactive releases from INEEL, in air and in water. These entities include the National Oceanic and Atmospheric Administration, the U.S. Geologic Survey, the State of Idaho's INEEL Oversight Program, the U.S. Environmental Protection Agency, the State of Idaho's Department of Environmental Quality, the Idaho Department of Water Resources, and numerous university research programs and private contractors. Ongoing studies by the Centers for Disease Control and Prevention, an agency of the U.S. Department of Health and Human Services, also

carefully tracks possible health effects from past activities at INEEL.

4.11.1.1 Radiological Health Risk

Very low doses of radiation are not known to cause health effects in humans; however, extrapolation of the dose-response relationship from high doses indicates that statistical effects might be observed in large populations. The doses reported in this EIS from INEEL operations are in this very low category. This EIS reports two values: collective dose (in person-rem) and the hypothetical number of latent cancer fatalities (LCFs). For effects on individuals, DOE reports dose in millirem and LCF probability.

Table 4-24 provides doses and LCF probabilities from annual exposure due to routine airborne releases for the noninvolved worker and maximally exposed individual near the site boundary for years 1995 and 1996. These doses are well below the current regulatory standard, which limits doses to the maximally exposed member of the public to 10 millirem per year (40 CFR 61).

Table 4-25 provides summaries of the dose and number of LCFs based on annual exposure to the surrounding population for 1995 and 1996. The surrounding population consists of approximately 120,000 people within a 50-mile radius of INEEL (ESRF 1997). The total collective population dose for 1996 of 0.24 person-rem corresponds to much less than one LCF within the entire population over the next 70 years (ESRF 1997). The conversion from collective dose to number of LCFs is performed using risk factors contained in the *1993 Limitations of Exposure to Ionizing Radiation* (NCRP 1993).

Production wells at INTEC and elsewhere on the INEEL are sampled and analyzed for gross alpha, gross beta, tritium, and strontium-90 (ESRF 1997). During 1996, all gross alpha concentrations were within the expected concentration range for naturally occurring alpha activity in the aquifer underlying the Snake River Plain, including INEEL. Two samples from an INTEC production well in June of 1996 had detectable levels of gross beta. Gross beta measurements are used for screening purposes. If a gross beta measurement exceeds the Maximum Contaminant Level, then the radioactive constituents in the sample are identified and doses are assessed. No detectable concentrations of tritium were found in the INTEC distribution samples. Because of the presence of the localized plume of strontium-90 in the groundwater near INTEC, staff at INEEL routinely sample several production wells at INTEC. While samples have historically contained detectable levels of strontium-90, none of the 1996 samples indicated detectable concentrations of strontium-90 (ESRF 1997).

Potential health effects to the offsite population from the lifetime groundwater pathway are reported in the SNF & INEL EIS and were calculated as an estimated LCF risk of 1 occurrence in 170 million.

Table 4-24. Annual dose to individuals from exposure to routine airborne releases at the Idaho National Engineering and Environmental Laboratory.

Maximally exposed individual	Annual dose (millirem)[a,b,c]	LCF Probability[d]
Onsite worker (1995)	0.32	1.3×10^{-4}
Offsite individual (public) (1995)	0.008	4.0×10^{-6}
Offsite individual (public) (1996)	0.03	1.5×10^{-5}

a. DOE (1995a), maximum dose at any onsite area from permanent facility emissions for onsite worker.
b. ESRF (1996) for offsite individual, 1995.
c. ESRF (1997) for offsite individual, 1996.
d. LCF = Latent cancer fatality

Table 4-25. Estimated increased health effects due to routine airborne releases at the Idaho National Engineering and Environmental Laboratory.

Year	Population dose (person-rem)[a,b]	Number of latent cancer fatalities
1995	0.08	4.0×10^{-5}
1996	0.24	1.2×10^{-4}

a. ESRF (1996) for year 1995.
b. ESRF (1997) for year 1996.

4.11.1.2 Nonradiological Health Risk

The potential health risk to workers and the public from exposure to carcinogenic and noncarcinogenic chemicals was assessed in Volume 2, Section 4.12.1 of SNF & INEL EIS. The assessment included the evaluation of health effects from routine airborne releases from facilities at INEEL. The three categories of exposed individuals were (1) a maximally exposed offsite individual, (2) population within 50 miles of INTEC, and (3) noninvolved worker. The potential nonradiological health effects to workers and the public from routine air emissions calculated in DOE (1995a) are summarized in the following paragraphs.

For non-occupational exposures to members of the public, data concerning the toxicity of carcinogenic and noncarcinogenic constituents were obtained from dose response values approved by the U.S. Environmental Protection Agency (EPA 1993, 1994). The values included slope factors and unit risks for evaluating cancer risks, reference doses and reference concentrations for evaluating exposures to noncarcinogens, and primary National Ambient Air Quality Standards for evaluating criteria pollutants. For the individual noncarcinogenic toxic air pollutants (such as fluorides, ammonia, and hydrochloric and sulfuric acids), all hazard quotients were less than one. (The hazard quotient is a ratio of the calculated concentration in the air to the reference concentration.) This indicates that no adverse health effects would be projected as a result of noncarcinogenic emissions. The offsite excess cancer risk from carcinogenic emissions (such as arsenic, benzene, carbon tetrachloride, and formaldehyde) ranged from 1 in 1.4 million to 1 in 625 million. Current emission rates for some toxic pollutants (carcinogenic and noncarcinogenic) are higher than the baseline levels assessed in the SNF & INEL EIS, but resultant ambient concentrations are expected to remain below reference levels for public and occupational exposure. The hazard quotients for maximum baseline offsite criteria air pollutants were all less than one. These results indicate that no adverse health effects were projected from criteria pollutant emissions (DOE 1995a). The recent actual site-wide emissions for criteria pollutants presented in Table 4-10 of this EIS would result in similar impacts. For each criteria pollutant except lead, the current (1995 and 1996) emission rates are less than

the levels assessed in the SNF & INEL EIS. Lead emission levels were about three times higher in 1996 (average hourly emissions) but still within applicable regulatory standards. Table 4-11 shows that ambient air concentrations offsite are all well below the ambient air quality standards.

For occupational exposures to workers at INEEL, DOE compared modeled chemical concentrations with the applicable occupational standard. The comparison was made by calculating hazard quotients, which for noncarcinogenic and carcinogenic air pollutants at INTEC were less than one. With one exception, the estimated INEEL concentrations of toxic air pollutants were estimated at levels well below those established for protection of workers. The exception was for maximum short-term benzene concentration, which slightly exceeded the standard at the maximum predicted location within the Central Facilities Area. These levels result primarily from emissions associated with petroleum fuel storage, handling, and combustion.

Drinking water from INTEC wells and distribution systems is routinely sampled for volatile organic compounds and for inorganic constituents (ESRF 1997). For 1996, the EPA maximum contaminant levels and the State of Idaho drinking water limits were not exceeded. For chemical carcinogens, these levels indicate an excess incidence of cancer risk of less than 1 occurrence in 1 million. For noncarcinogenic chemical contaminants these levels indicate that no adverse health effects are expected as a result of these contaminants. Potable water at INEEL was monitored for coliform bacteria. No samples showed positive results for coliform at INTEC (ESRF 1997).

4.11.2 OCCUPATIONAL HEALTH AND SAFETY

The radiation doses and nonradiological hazards presented here are based on personnel monitoring data and reported occupational incidences at INEEL. For occupational exposure to ionizing radiation, health effects assessments are based on actual exposure measurements. For routine workplace hazards, the health risk is presented as reported injuries, illness, and fatalities in the workforce.

Risks to the worker are reduced by instituting health and safety programs. DOE relies on a program to keep worker exposures to radiation and radioactive material as low as reasonably achievable (ALARA). An effective ALARA program must balance minimizing individual worker doses from external and internal sources with the goal to minimize the collective dose of all workers in a given group. ALARA evaluations must consider individual and collective doses to ensure the minimization of both within the practical limits associated with minimization balancing. INEEL worker doses have typically been well below DOE worker exposure limits, and DOE will continue to use the ALARA program to maintain this level of safety.

DOE's Voluntary Protection Program was established to promote and recognize highly effective safety and health programs. Through the DOE-Voluntary Protection Program, INEEL's operating contractor has established a cooperative relationship in which management administers a comprehensive program that exceeds mere compliance and employees actively participate in the program and work with management to ensure a safe and healthful work site (LMITCO 1998).

Worker safety is also improved by the new Integrated Safety Management System. The INEEL Integrated Safety Management System Program Description (LMITCO 1999) is a document that defines the safety culture for INEEL. Safety at INEEL has been governed by many different procedures. This new plan outlines how all of the various safety programs, procedures, and documents relate to and integrate with each other. The term "safety" includes all aspects of environmental, safety, and health management including pollution prevention and waste minimization. The Plan covers the issues, responsibilities, methodologies, documents, and training (safety culture) that protects the worker, noninvolved worker, public, environment, and programmatic facilities (environmental targets).

4.11.2.1 Radiological Exposure and Health Effects

Radiological workers are trained to work safely in areas controlled for radiological purposes. Radiological workers at INEEL and INTEC may be exposed either internally (from inhalation and ingestion) or externally (from direct exposure) to radiation. The largest fraction of occupational dose received by INEEL and INTEC workers is from external radiation from direct exposure. The average occupational dose from 1992 to 1996 to individuals with measurable doses was 150 millirem, which results in an average annual collective dose of about 202 person-rem (DOE 1995b; DOE 1997a). This collective dose corresponds to 0.08 LCFs resulting from each year of exposure to INEEL personnel, including INTEC personnel. The average occupational dose DOE-wide from 1992 to 1996 to individuals with measurable doses was 72 millirem, which results in an average annual collective dose of about 1,812 person-rem (DOE 1995b; DOE 1997a); this corresponds to 0.72 LCFs resulting from each year of exposure to all DOE workers. For airborne emissions (as shown in Table 4-24), the maximum dose to an onsite worker from permanent facility emissions is 0.32 millirem.

4.11.2.2 Nonradiological Exposure and Health Effects to the Onsite Population

At INEEL, occupational nonradiological health and safety programs include industrial hygiene programs and occupational safety programs. Total recordable case rate for injury and illness incidence at INEEL varied from an annual average of 3.1 to 3.7 per 200,000 work hours from 1992 to 1996. During this time, total lost workday cases ranged from 1.3 to 1.8 per 200,000 work hours (DOE 1997b). The total recordable case rate for injury and illnesses for INEEL workers is less than that for DOE and its contractors at other facilities, which varied from 3.5 to 3.8 per 200,000 work hours. During this time, total lost workday case rate varied from 1.6 to 1.8 per 200,000 work hours (DOE 1997b). Two fatalities have occurred at INEEL between 1992 and July 1998. One incident occurred when a construction worker fell from an elevated area. The second incident occurred when a carbon dioxide fire suppression system activated during routine maintenance in an electrical switchgear building, causing asphyxiation of one employee.